

REMARKS

Review and reconsideration on the merits are requested.

With respect to **Election/Restrictions**, the Examiner correctly presents Applicants' election.

Specification

The Examiner objects to the specification on the ground that it is unclear to the Examiner what the Q value means since there appears to be contradictions throughout the specification and it is a term not known to one of ordinary skill in the art to characterize a polymer electrolyte membrane or a membrane electrode assembly by a Q value. Although the Examiner cites certain paragraphs in the specification, in the order discussed by the Examiner, Applicants believe these correspond to the specification at page 9, lines 7-16 (Paragraph 39), page 10, lines 13-16 (Paragraph 42) and page 30, lines 9-11 (Paragraph 135).

The Examiner also finds it unclear how the unit area of the membrane electrode assembly is measured in Paragraph 42.

Applicants would like to explain the Q value described at page 9, lines 5-16 of the specification as follows.

The basic concept of the Q value described in the specification is found at page 8, line 28 to page 9, line 2 and page 9, lines 5-12, where it is stated as follows:

"At least in the second membrane electrode assembly, the polymer electrolyte membrane should have a Q value (charge per a unit area) of 0.09-0.18 C/cm²."

¶ The particularly preferably Q value of the polymer electrolyte membrane is 0.14-0.18 C/cm². Here, the Q value is the amount of electric charge per a unit area determined from a peak

area of proton on an adsorption side in the scanning of voltage from -0.1 V to +0.7 V, in a cell in which the amount of platinum in the catalytic layer of each electrode is 0.5 mg/cm^2 , and in which a polymer electrolyte membrane electrode assembly is surrounded by an aqueous sulfuric acid solution of pH 1 on one side and a nitrogen gas on the other side. //

Because the Q value of a polymer electrolyte membrane cannot be measured without using a structure of a membrane electrode assembly consisting of the polymer electrolyte membrane formed on only one side of an electrode as shown in Fig. 3, the Q value of a polymer electrolyte membrane measured by such a membrane electrode assembly of a single cell is the Q value of the membrane electrode assembly of the single cell having the polymer electrolyte membrane formed only on the one side of the membrane electrode assembly. Therefore, in the specification of the present application, the term “the Q value of the polymer electrolyte membrane” is the “the Q value of the membrane electrode assembly of the single cell (used for measuring the Q value of the polymer electrolyte membrane)”.

Since the structure of the membrane electrode assembly of the single cell used for measuring the Q value of the polymer electrolyte membrane does not have a perfect structure as the polymer electrolyte membrane electrode assembly used for the polymer electrolyte fuel cell, its Q value should not be referred to as “the Q value of the membrane electrode assembly” but should be referred to as “the Q value of the polymer electrolyte membrane.”

Thus, the Q value can be defined more specifically as “the Q value is the amount of electric charge per a unit area determined from a peak area of proton on an adsorption side, which is indicated by the shadowed portion in a discharge curve obtained as a result of measuring a current density shown in Fig. 3, divided by an area of the polymer electrolyte membrane in the membrane electrode assembly of the single cell while the voltage is applied

between an aqueous sulfuric acid solution and an electrode in the scanning of voltage from -0.1 V (showing an inflection point) to +0.7 V (showing the current density = 0) in the single cell that the electrode 100 containing 0.5 mg/cm² of platinum is formed on one side surface of the polymer electrolyte membrane 101 and the polymer electrolyte membrane is surrounded by an aqueous sulfuric acid solution 109 of pH 1 on another side surface of the electrode while nitrogen gas is flowing through the electrode 100.”

In this regard, the Q value of each polymer electrolyte membrane in a membrane electrode assembly of the single cell shown in Fig. 2 is measured as described at page 9, line 17 to page 10, line 16 of the specification, and the Q value of the membrane electrode assembly for a polymer electrolyte fuel cell as shown in Fig. 1 is not measured.

It is believed that the above should clarify the Q value issue, but if the Examiner would like any additional information, the Examiner is requested to contact the undersigned at the later given telephone exchange.

The specification is amended to reflect the above discussion.

Claim Rejections - 35 U.S.C. § 112

Claims 3, 5-11, 16 and 17 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite.

The Examiner’s position is set forth in some detail at pages 4-6 of the Action, and will not be repeated here except as necessary to an understanding of Applicants’ traversal which is now presented, noting that claims 3 and 11 have been combined with claims 1 and 10, respectively, and claims 3 and 11 have been canceled.

With respect to the Examiner's rejection of claim 5, the Q value is defined as the amount of electric charge per a unit area of the polymer electrolyte membrane in the membrane electrode assembly, as above discussed. It is believed that the Examiner's rejection of claim 5 is avoided by the above explanation about the Q value of the polymer electrolyte membrane.

With respect to the Examiner's rejection of claims 10 and 16, the recitation "wherein said polymer electrolyte membrane is made of a sulfonated hydrocarbon polymer that may contain oxygen in its skeleton or other substituent groups than a sulfonic group" includes non-fluorinated polymers having a carbonyl (-CO-) group, an ether (-O-) group, a sulfone (-SO₂-) group, a sulfide (-S-) group, an imide (-NH-) group, etc., in the polymer skeletons or substituent groups composed of hydrocarbons, and thus specific examples of these sulfonated hydrocarbon polymers are sulfonated polyetheretherketone, sulfonated polysulfone, sulfonated polyethersulfone, sulfonated polyetherimide, sulfonated polyphenyl sulfide and sulfonated polyphenylene oxide (see page 8, lines 6-14 of the specification).

These sulfonated hydrocarbon polymers may be prepared from hydrocarbon polymers having a carbonyl (-CO-) group, an ether (-O-) group, a sulfone (-SO₂-) group, a sulfide (-S-) group, an imide (-NH-) group, etc., in the polymer skeletons or substituent groups composed of hydrocarbons by the sulfonation thereof.

With respect to the Examiner's rejection of claims 3 and 8, claim 3 has been canceled. The recitation "the distance along said interface is longer than said linear distance by 15% or more on average" in these claims is as explained in the specification page 12, line 28 to page 13, line 12, referring to Fig. 6, as follows.

As shown in Fig. 6, by selecting two points A, B (n pairs in an interface 11), whose linear distance L_0 is 10 μm or more, the length of the interface 11 L_n in a wave form between the polymer electrolyte membrane 1 and the electrode catalytic layer 22 can be measured by a map meter, etc. (see page 13, lines 6-8 of the specification). After measuring n pairs of the distance in a wave form between two point A, B, an average distance of $\Sigma L_n/n$ (usually, n is 7 or more) between the two points A, B along the interface 11 (simply called “interface length”) can be easily obtained. Claims 3 and 8 recited:

“when there are arbitrary two points, whose linear distance is 10 μm or more, in an interface of the polymer electrolyte membrane with each of the catalytic layers, the distance along the interface is longer than the linear distance by 15% or more on average.”

These characteristic features of the claimed invention find support at page 25, Examples 1-7 in Table 1, the column “Average Interface Length Ratio ($\Sigma L_n/n/L_0$),” where the length of an interface between the catalytic layer and the polymer electrolyte membrane was measured at 9 points ($n = 9$), to determine an average interface length from the measured values.

It should be noted that the first membrane electrode assembly of the present invention comprises a pair of opposing electrodes each having a catalytic layer, and a polymer electrolyte membrane sandwiched by the electrodes, part of the catalytic layers projecting into the polymer electrolyte membrane (emphasis added) (see page 4, line 13 of the specification). This distinguishing feature of the present invention is reflected in various effects obtained, such as the membrane electrode assembly exhibits not only a function inherent in an electrode catalyst, but also a function to generate water by the reaction of oxygen gas and hydrogen gas cross-leaking through the polymer electrolyte membrane 1. Because water formed by cross-leaking in the

electrode/membrane interface under a low humidity condition and water formed by an electrode reaction are efficiently diffused into the polymer electrolyte membrane 1, low-humidity operation is achieved (see page 12, lines 4-12 of the specification).

This means that the discontinuous portions caused by discrete catalyst particles might be included into the projections between an interface of the polymer electrolyte membrane and each of the catalytic layers.

Withdrawal of the rejections is requested.

Amendments to claims

Claim 1 is limited by incorporating claims 2 and 3 therein to make amended claim 1 on which claim 4 is dependent.

Claim 10 is amended by incorporating claim 11 therein to make amended 10 in independent form, and further claim 16 is rewritten in independent form with the sulfonated hydrocarbon polymer defined.

In amended claim 16, the sulfonated hydrocarbon polymer finds support at page 8, lines 10-14 of the specification.

Applicants now turn to the art rejections.

Prior art considered: U.S. 2002/55034A1 Fukuda et al (Fukuda); U.S. Patent 5,272,017 Swathirajan et al (Swathirajan); U.S. Patent 6,136,412 Spiewak et al (Spiewak); U.S. Patent 5,795,496 Yen et al (Yen).

Addressing first the rejection of Paragraph 7 and Paragraph 8 of claims 1-4, 10-12, 5-9, 16 and 17 under 35 U.S.C. § 102(e) over Fukuda, Fukuda was filed August 30, 2001. Applicants

plan to avoid Fukuda as prior art by filing verified English translations of their two priority applications, JP 2001-12491 and '493, both filed January 19, 2001. These will be lodged in the very near future.

Applicants now address and traverse the rejection of claims 1-4, 10 and 12 under 35 U.S.C. § 102(b) as anticipated by Swathirajan.

Applicants present here amended claim 1:

1. (currently amended): A membrane electrode assembly comprising a pair of opposing electrodes each having a catalytic layer, and a polymer electrolyte membrane sandwiched by said electrodes, part of said catalytic layers being projecting into said polymer electrolyte membrane, wherein the projection depth of said catalytic layer is 0.5 μm or more and less than 5 μm , and wherein when there are arbitrary two points, whose linear distance is 10 μm or more, in an interface of said polymer electrolyte membrane with each of said catalytic layers, the distance along said interface is longer than said linear distance by 15% or more on average.

A major distinguishing feature of the claimed invention lies in that projection depth of the catalytic layer is 0.5 μm or more and less than 5 μm and when there are arbitrary two points, whose linear distance is 10 μm or more, in an interface of the polymer electrolyte membrane with each of the catalytic layers, the distance in a wave form along the interface is longer than the linear distance by 15% or more on average, whereby an excellent self-humidifying function is realized to perform low-humidifying operation without sacrificing power generating performance in a polymer electrolyte fuel cell formed by stacking such membrane electrode assemblies via separator plates (see page 37, lines 4-11 of the specification).

In contrast, Swathirajan does not teach or suggest any projection of the catalyst layer and any distance along the interface. Therefore, one skilled in the art referring to Swathirajan would

not reach the invention of the amended claim 1, and, accordingly, amended claim 1 of the present application is not anticipated by or obvious over Swathirajan.

Claim 10 of the present application has been rewritten in independent form by combining with amended claim 1 and claim 11 to clarify the patentable features of claim 10 reciting a polymer electrolyte membrane made of a sulfonated hydrocarbon polymer than may contain oxygen in its skeleton or other substituent groups than a sulfonic group where the sulfonated hydrocarbon polymer is selected from the group consisting of sulfonated polyetheretherketone, sulfonated polysulfone, sulfonated polyethersulfone, sulfonated polyetherimide, sulfonated polyphenylene sulfide and sulfonated polyphenylene oxide.

In contrast, Swathirajan is silent regarding various kinds of sulfonated hydrocarbon polymers except for commercially available sulfonated perfluorocarbons such as "NAFION," and the like (see column 4, lines 18-58).

Since amended claim 1 of the present application is not anticipated by or obvious over Swathirajan, amended claim 10 of the present application is not anticipated by or obvious over Swathirajan.

For remaining claims rejected, Applicants rely on their arguments above.

Withdrawal is requested.

Applicants now address and traverse the rejection of claims 1-4, 10 and 12 under 35 U.S.C. § 102(b) based on Spiwak.

Claim 10 of the present application has been rewritten in independent form by combining it with amended claim 1 to make amended claim 10, which has been combined with claim 11.

Although Spiewak discloses a membrane electrode or membrane electrode assembly (MEA) comprising an ion conducting membrane (ICM) and one or more electrode layers that comprise nanostructured elements, which further comprise a catalytic material, wherein the nanostructured elements are in incomplete contact with the ICM, that is, where greater than 0% and less than 99% of the volume of the elements is embedded in the ICM (see column 3, lines 17-24), and, specifically, in the membrane electrode assembly (MEA), catalyst electrodes are incorporated into very thin surface layers (localized within 2 μ m of the interface on either side of an ion conductive membrane (ICM) and in which the catalyst electrode particles are in incomplete contact with the (ICM) (emphasis added) (see column 7, lines 21-25, column 8, line 10 and Figs. 2 and 3), Spiewak is silent regarding the distance in a wave form along the interface.

In contrast, in the invention of claim 1 of the present application, as above discussed, the distance in a wave form along the interface between the polymer electrolyte membrane and each of the catalytic layers is longer than the linear distance by 15% or more on average, whereby an excellent self-humidifying function is realized to permit low-humidifying operation without sacrificing power-generating performance in a polymer electrode fuel cell formed by stacking such membrane electrode assemblies via separator plates (see page 37, lines 4-11 of the specification).

Therefore, one skilled in the art referring to Spiewak would not easily reach the invention of amended claim 1, and, accordingly, amended claim 1 of the present application is not

anticipated by or obvious over Spiewak, which fails to teach or suggest at least the distance in a wave form along the interface.

With respect to amended claim 10 of the present application, Spiewak fails to teach or suggest the various kinds of sulfonated hydrocarbon polymers recited therein, except for fluorocarbon-type ion-exchange resins including “Nafion.” Further, amended claim 1 of the present application (included in claim 10) is not anticipated by or obvious over Spiewak.

Therefore, one skilled in the art referring to Spiewak would not reach the invention of amended claim 10, and, accordingly, the amended claim 10 of the present application is not anticipated by or obvious over Spiewak.

With respect to the remaining rejected claims, Applicants rely upon the above arguments.

Withdrawal is requested.

Applicants now address and traverse the rejection of claim 11 under 35 U.S.C. § 103(a) based on Swathirajan in view of Yen.

Claim 11 of the present application has been incorporated into claim 10 to make amended claim 10, which has been rewritten in independent form by combining with amended claim 1.

As earlier discussed, amended claim 1 of the present application is not obvious over Swathirajan.

Since claim 11 of the present application is incorporated into claim 10 to make limited amended 10 and the amended claim 10 is rewritten in independent form by combining with the amended claim 1, clearly amended claim 10 is patentable over Swathirajan.

However, the rejection is a combination rejection, and Applicants now turn to Yen.

Although Yen discloses sulfonated polyetheretherketone as an electrolytic membrane for fuel cells, Yen fails to teach or suggest a membrane electrode assembly comprising a pair of opposing electrodes each having a catalytic layer, and a polymer electrolyte membrane sandwiched by the electrodes, part of the catalytic layers being projecting into the polymer electrolyte membrane, wherein, the projection depth of the catalytic layer is 0.5 μm or more and less than 5 μm , and wherein when there are arbitrary two points, whose linear distance is 10 μm or more, in an interface of said polymer electrolyte membrane with each of said catalytic layers, the distance along the interface is longer than the linear distance by 15% or more on average.

Therefore, one skilled in the art referring to Yen would not be motivated to reach the invention of the amended claim 10, and accordingly, amended claim 10 of the present application is not obvious over Yen.

Further, the combination of Swathirajan and Yen does not teach or suggest at least the distance in a wave form along the interface between the interface between the polymer electrolyte membrane and each of the catalytic layers, which are important features in the present application, regardless of the various kinds of the sulfonated hydrocarbon polymers. Accordingly, amended claim 11 (now in claim 10) of the present application is not obvious over Swathirajan even in combination with Yen.

Withdrawal is requested.

Applicants now address and traverse the rejection of claim 11 under 35 U.S.C. § 103(a) as being unpatentable over Spiewak in view of Yen.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 10/050,518

Again, Applicants note that claim 11 of the present application has been incorporated into claim 10 to make amended claim 10, which has been rewritten in independent form by combining with amended claim 1.

As earlier discussed, amended claim 1 of the present application is not obvious over Spiewak.

Since claim 11 of the present application is incorporated into claim 10 to make limited amended 10 and the amended claim 10 is rewritten in independent form by combining with amended claim 1, clearly amended claim 10 is not obvious over Spiewak.

Further, as earlier discussed, amended claim 10 of the present application is not obvious over Yen.

For the reasons earlier advanced, Applicants respectfully submit that the combination of Spiewak and Yen does not render claim 11 (now in claim 10) obvious.

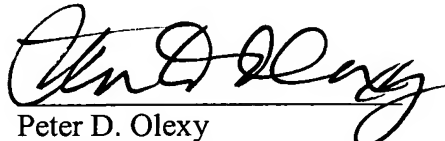
Withdrawal of all rejections is requested.

Since the obviousness-type double patenting rejection is only provisional, no comments are offered thereon at this time.

AMÉNDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 10/050,518

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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